Chapter 1 – Introduction

Collaborative learning endorses active student participation in the learning process. In collaborative learning, students generally work together in small groups towards a shared learning goal. Collaborative learning emphasizes the collaborative efforts among students in their group along with the teachers' guidance. Students are accountable for their group members' learning as well as their own. Hence, the success of one student helps other students to be successful (Gokhale, 1995).

As Gokhale (1995) asserted, the concept of collaborative learning as well as the grouping and paring students for the purpose of achieving an academic goal has been widely researched and advocated throughout professional literatures. Therefore, it is undoubtedly that many of the collaborative learning benefits had been identified to date (Panitz, 1997a). For instance, collaborative learning enables more challenging tasks to be carried out without making the workload unbearable. Students engage in collaborative learning tend to be more active throughout the learning process. Besides, collaborative learning encourages diversity understanding by giving students the opportunity to express their opinions and discuss them in groups.

Collaborative Learning Activities in Primary Schools

Collaborative learning is a useful teaching method that can help teachers and students accomplish specific learning goal (Enerson et. al., 1997). Collaborative learning activities may range in size either from small assignment groups to large and complicated class projects. Class or group discussion, collaborative projects, group presentation and notes sharing are some of the common collaborative learning activities carried out in the primary schools (Walker et. al., 2000; Kasirun and Salim, 2001).

Traditionally, collaborative learning activities are carried out face-to-face in a classroom. Students engaging with collaborative activities are divided into small groups. In this way, student in a large class are given the opportunity to interact on a smaller scale, and prepare students for "real world" (Enerson et. al., 1997). For example, in a group discussion activity, students in a classroom are divided into smaller groups. These groups are given some reading materials and the students are required to discuss them in their group. Then, students of each group must present the discussion outcomes to the whole class in turns.

Nevertheless, collaborative learning activities require a lot of preparation (Enerson et. al., 1997). The success of a collaborative activity depends on the appropriateness of the task that students are asked to perform. As a result, preparing collaborative learning materials for students to carry out manually in a classroom is very time consuming. Fortunately, the rapid expansion and availability of communication and information technologies have made these collaborative learning activities possible to be carried out with the use of technologies.

Technologies for Supporting Collaborative learning Activities

The Internet started to emerge when the National Science Foundation, US withdrew most of its funding and opened the Internet to commercial organizations in 1991. The Internet begins to grow swiftly along with the creation of World Wide Wide (WWW) by Tim Berners-Lee (Aitken, 1999). Ever since then, the web has greatly revolutionizes the way of collecting, processing and manipulating information. Many of the traditional meaning and process of business, commerce, marketing, finance, publishing, education, research and development as well as other aspects of daily life are redefined and modernized (Aitken, 1999).

As the computational technologies emerge along with the prevailing wave of Internet and WWW, some collaborative learning activities are also being shifted to the electronic environments through various types of tools and applications (Scardamalia and Bereiter, 1994; Edelson et. al., 1995; Gibbs, et. al., 1998; Suthers, 1998). Under this new paradigm, new forms of computer mediated learning environment such as Computer Supported Collaborative Learning (CSCL) is introduced. CSCL refers to the field of study that examines the design, adoption and use of groupware. Groupware is a technology designed to facilitate the work of groups. It may be used to communicate, cooperate, solve problems, compete or negotiate (Brinck, 1998).

The rapid growth of network infrastructure and WWW has made both synchronous and asynchronous communication become feasible through the Internet. Hence, CSCL applications can support collaborative learning activities through synchronous and/or asynchronous collaboration. Synchronous collaboration involves the parties (learners, or learner and instructor) being online at the same time and communicating in real-time. On the other hand, asynchronous collaboration involves the parties communicating over elapsed time.

To date, even though there are quite a number of CSCL applications that have been developed to support collaborative learning activities using computer technology through the network and Internet, nevertheless, little attention little attention has been paid to how CSCL applications can support children's collaborative learning (Crawley, 1997b; Cockburn and Greenberg, 1998). In a study conducted by Crawley (1997), only two out of the thirteen CSCL applications support children's collaborative learning. Cockburn and Greenberg (1998) further affirm that although much has been learned about how adults work together through groupware, little attention has been paid to how

children collaborate through real-time groupware. If primary school teachers are provided with the right CSCL applications, they will be able to carry out the collaborative learning activities in their teaching curriculum (Salim, et. al., 2001). As a result, there is an increasing demand on CSCL applications which support children collaborative learning.

In parallel with the successful of Internet and WWW, the agent arena is facing an increasingly active, rapidly evolving and expanding progress. The agent technology is expected to be eventually as profound as the WWW. Web agents have many potential roles in assisting both teachers and students in carrying out their collaborative learning activities (Lang, 1995; Lashkari, 1995; Pazzani el. at., 1996; Starr et. al., 1996; Joachims et. al., 1997; Luke and Hendler, 1997). At the time of writing, there are already a few efforts that attempt to deploy web agents in the educational arena (Adriano et. al., 1999; Jafari, 1999; Andoh et. al., 2001). However, the review on these agent systems indicated that the use of web agents for supporting the collaborative learning is not fully explored yet.

1.1 Research Overview

This thesis presents a web-based tool which utilizes the web agents to support jigsaw collaborative learning activity. It intends to formulate a process model to support the teachers' proposed module namely G-Jigsaw during a workshop conducted in year 2000. It describes how the G-Jigsaw process model restructures the initial level of the jigsaw activity based on the teachers' proposal and Aronson's Jigsaw Classroom (Aronson and Patnoe, 1997) to enable the students to collaborate at every level throughout the jigsaw session. Further, it presents the development and implementation

of a G-Jigsaw that incorporates the process model. It also describes how a multi-agent architecture formulated in enabling the web agents to simplify and automate the jigsaw activities. Finally, it highlights the teachers (pilot testing) and students (hands-on testing) evaluations as well as the research contributions and future enhancements.

1.2 Research Motivations

This research is motivated by three main trends, i.e. the emergence of the Internet and WWW, the demands of CSCL applications for primary education as well as the maturity and rapid growth of agent technology. The first trend provides a vast network infrastructure that makes the use of information and communication technology (ICT) feasible. The second trend enables the primary school teachers to carry out collaborative learning activities in their teaching curriculum more easily and the last trend has great potentials in augmenting some complex collaborative activity's flows and processes as well as performing some back end tasks on behalf of its user.

The advancement of Internet together with the emergence of WWW has provided an effective medium for web-based collaborative learning (Eugenia and Ada, 2002). This evolution towards a dynamic learning environment through the web has led to an intensive necessitate for communication, collaboration and problem solving. Thus, it is plausible to assume that there is an increasing demand on web-based collaborative learning applications that utilize the Internet and WWW as a medium of communication and interaction to support the collaborative learning activities.

Studies on most of the well known CSCL applications indicated that most of these applications emphasized more on higher education and distance learning collaboration.

Very little attentions are being paid for students in lower education (Crawley, 1997b). In Malaysia particularly, countless hours of searching the journals, conference papers and Internet revealed that no CSCL applications for primary school students are being developed. Investigations carried out by Kasirun and Salim (2001) also highlighted the lack of CSCL applications for schools in Malaysia. Thus, there are needs to identify, design and develop CSCL applications for the teachers and students to carry out collaborative learning activities in Malaysian's primary schools.

At the same time, there is also a drastic switch in software agent development towards Information/Internet agents, or more commonly known as web agents, where they fully utilize the Internet and WWW as a medium of interaction. Web agents are automated programs, which perform tasks of gathering, clustering and filtering information from the web on behalf of their users. In conjunction with this swiftly information superhighway, web agents are getting more and more important roles in the software agent research and development that reside on various domains. The studies of web agents in supporting the collaborative learning activities can help to enhance the collaborative learning applications (Jafari, 1999; Andoh et. al., 2001).

1.3 Research Objectives

The research reviews on the collaborative learning and software agent literature, specializing on the jigsaw technique and web agents, in an attempt to develop a web-based tool called G-Jigsaw in supporting jigsaw collaborative learning technique for Malaysian primary schools. The objectives of this research are summarized as follow:

i. To formulate a G-Jigsaw process model that promotes primary students collaboration in a web-based environment.

ii. To formulate a multi-agent architecture that supports the deployment of web agents to automate and simplify the jigsaw activities.

iii. To develop G-Jigsaw, a web-based tool that incorporates the jigsaw process model in supporting primary students' collaborative learning.

iv. To conduct testing for teachers and students in primary schools to evaluate the success of G-Jigsaw.

1.4 Research Scopes

In concurrence with the objectives, the scope of the thesis is defined in order to provide a general guideline on the range and depth of the research. The following statements summarize the scope of the thesis in accordance with the stated objectives:

i. Collaborative learning is a very broad research domain to be studied. This research focuses on CSCL applications that support primary school students' collaborative learning. Other domains of collaborative learning will not be covered.

ii. The field of software agent is rooted from artificial intelligence. However this research does not focus on the artificial intelligence aspects. The emphasis of this research is to utilize the web agent technology in supporting the student's collaborative learning activities. Thus, issues such as intelligent agents will not be considered.

iii. The web agents developed are aimed to automate and simplify the jigsaw activity flows and processes in supporting the student's collaborative learning. Other aspects of web agent implementation such as assessment agents or pedagogical agents are not in the scope of this research.

iv. The testing is intentionally customized for primary teachers and students.

Further testing on how G-Jigsaw will support the secondary schools, colleges and universities students are beyond the scope of this research.

1.5 Research Methodology

The methodology used in this research comprises the following steps as listed below:

1. Carrying out reviews in the field of collaborative learning, focusing on the collaborative learning activities, various collaborative learning techniques as well as the inadequacy of CSCL applications in supporting primary schools education in Malaysia.
2. Inviting a group of primary school teachers to participate in a workshop. The workshop aims to brainstorm the collaborative learning activities carried out in their primary schools and the problems that occurred, as well as to propose modules in supporting activities that are suitable to be carried out in primary schools in Malaysia. G-Jigsaw is one of the proposed modules which is the focus of this research.
3. Identifying and eliciting the system requirements from the literature review and workshop. The literature review provides foundation for the techniques and technologies to support various collaborative learning activities while the workshop provides real life teaching experiences on how these collaborative learning activities can be conducted in a classroom.
4. Formulate a G-Jigsaw process model based on the teachers' proposal and Aronson's Jigsaw Classroom. The process model modifies Aronson's Jigsaw Classroom to fulfill the proposed G-Jigsaw's requirements by restructuring the first level jigsaw activities. This enables student collaborations at every level throughout the jigsaw collaborative learning session.

5. Developing a prototype to incorporate the process model. This prototype provides a good understanding on how well the process model has been incorporated. It serves as a blueprint on how the prototype can be further enhanced.
6. Carrying out reviews on software agent, specializing in web agents, on how to support collaborative learning utilizing web agents. Based on the reviews, the process model and the developed prototype, the potentials of web agents are identified.
7. Developing a multi-agent architecture to support the deployment of web agents. The architecture facilitates the web agents' communication in order to automate and simplify the complex jigsaw process.
8. Implementing a web-based tool called G-Jigsaw. G-Jigsaw provides a web-based collaborative environment and tools for students to participate in jigsaw activities.
9. Evaluating the success of G-Jigsaw by conducting a pilot test with teachers. The suggestions and feedbacks are collected via questionnaire. The bugs and errors detected from the pilot test are fixed. The flow and functionality of G-Jigsaw are improved.
10. The enhanced version of G-Jigsaw is re-evaluated through the student hands-on testing. The feedback is gathered via questionnaires.
11. Producing the first version of G-Jigsaw as a web-based tool to support jigsaw-type collaborative learning.

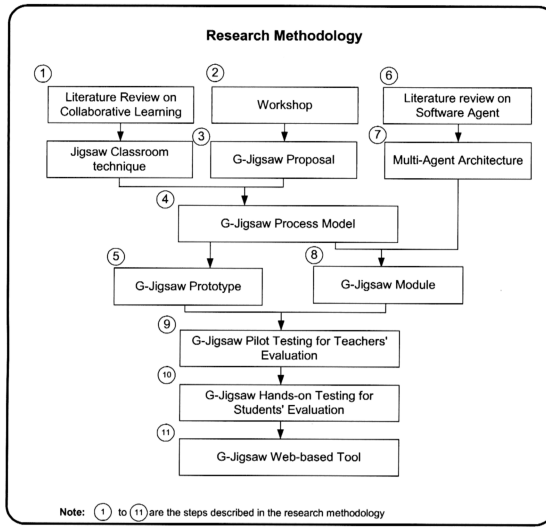

Figure 1-1 Research Methodology

1.6 Thesis Organization

The organization of this thesis is generally divided into three parts. The first part of the thesis, comprising chapters 2, 3 and 4 cover the literature review, investigation and discussion of various aspects on collaborative learning and software agents as well as introducing a process model in supporting the jigsaw collaborative learning technique.

Chapter 2 investigates the theoretical aspects of collaborative learning in supporting primary schools collaborative learning activities, which serves as the domain of this research. Specifically, it covers the collaborative learning definition, its benefits and

drawbacks and various collaborative learning activities with different collaborative learning techniques. It highlights the CSCL applications and focused on how CSCL can be implemented in Malaysian primary schools. It also presents the WebCL (Web-Based Collaborative Learning System) project and its workshop evaluation.

Chapter 3 introduces a G-Jigsaw process model to support the jigsaw collaborative learning. It studies Aronson's Jigsaw Classroom technique and discusses the formation of the process model in depth. It also investigates tools that support the jigsaw technique. Chapter 4 reviews on various aspects of software agents. These include agents' definitions, typologies and architectures. Then, it specifically focused on web agents, as well as its categories and deployment in supporting collaborative learning activities.

The second part of the thesis, consisting chapter 5 and 6 covers the development of G-Jigsaw. Chapter 5 presents the analysis and design of G-Jigsaw. Chapter 6 further explains the implementation of G-Jigsaw along with the deployment of web agents.

The last part of the thesis consist of chapter 7 and 8, which depicts the evaluation and results of G-Jigsaw as well as its future enhancements. The G-Jigsaw's evaluations are enclosed in Chapter 7. Finally, chapter 8 concludes the entire thesis, highlights the research contributions that have been achieved and provides some suggestions for future work on this research.